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ANNUAL REPORT AND PROGRAM

APPALACHIAN FOREST EXPERIMENT STATION

1929-1930

APPALACHIAN FOREST EXPERIMENT STATION

PERSONNEL, 1929

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C. R. Hursh	Forest Ecologist
J. H. Buell	Assistant Silviculturist
I. H. Sims	Junior Forester
A. L. MacKinney	Junior Forester
C. A. Abell	Junior Forester
Josephine Laxton	Senior Clerk
Elisa M. Pearson	Clerk
Lillian B. King (Assigned to Station Jan.,1930)	Stenographer

BUREAU OF ENTOMOLOGY

J. A. Beal — Assistant Entomologist
(Transferred from the Station in June, 1929)

BUREAU OF PLANT INDUSTRY

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BIOLOGICAL SURVEY

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(Assigned to Station Jan., 1930)

TEMPORARY ASSISTANTS, 1929

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APPALACHIAN FOREST RESEARCH COUNCIL

MEMBERSHIP IN 1929

W. D. Tyler — President

J. H. Pratt, Chairman of Executive Committee

Kentucky

T. P. Cooper, Director, Kentucky Agr. Experiment Station, Lexington.
W. J. Hutchins, President, Berea College, Berea.

North Carolina

G. A. Cardwell, Atlantic Coast Line Railway, Wilmington.
Andrew Gennett, President, Gennett Lumber Co., Asheville.
J. S. Holmes, State Forester, Raleigh
J. H. Pratt, Consulting Engineer, Chapel Hill.
Verne Rhoades, Consulting Forester, Asheville.
R. B. Robertson, President, Champion Fibre Company, Canton.

South Carolina

H. L. Tilghman, Tilghman Lumber Company, Marion.

Tennessee

S. F. Horn, Editor, Southern Lumberman, Nashville.
R. S. Maddox, State Forester, Nashville.

Virginia

P. R. Camp, Camp Manufacturing Co., Franklin.
J. P. Hummel, Hummel-Ross Fibre Corporation, Hopewell.
Chapin Jones, State Forester, Charlottesville.
W. D. Tyler, Clinchfield Coal Company, Dante.
George L. Wood, R. E. Wood Lumber Company, Hotchkiss.

West Virginia

A. B. Brooks, Waddington Farm, Wheeling.
T. H. Clagett, Chief Engineer, Pocahontas Coal & Coke Co., Bluefield.
George D. Curtin, Pardee & Curtin Lumber Company, Clarksburg.
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Field of Work of the Appalachian Station

The Station's territory and field of activities in 1929-30 are as described in the annual reports for the two preceding years. The territory includes the States of West Virginia, Virginia, North and South Carolina, eastern Kentucky and Tennessee, and northern Georgia and Alabama. From a forestry point of view the region is made up of three types of country, which differ widely in topography, forest conditions, and economic development. The central part is mountainous, with large tracts of hardwood timberland, now mostly cut over. Though it comprises only about a fifth of the Station's territory, the mountain region contains 21,000,000 acres of actual or potential timberland, amounting to about 80 per cent of the total land area in the mountains. Eight national forests in the mountain region occupy about 1,989,000 acres. The mountains are thinly populated.

Over half of the Station's territory is embraced in the rolling plateaus and valleys that surround and penetrate the mountain ranges. This is primarily agricultural country, well populated, with many industrial towns and cities. The regional consumption of wood products is centered largely on the plateaus, where wood-using industries are numerous and varied. Only about 51 per cent of the land surface is wooded, and the greater part of the woodland is in small holdings, on the farms. Though individually small, these farm woodlands aggregate over 23,000,000 acres, and their accessibility to towns and cities, as well as to the farms, gives them great importance as sources of future timber supply. There are in addition about 16,000,000 acres of land not on farms, largely potential timberland.

The third region is the coastal plain, in which southern pines--chiefly loblolly and longleaf pine--and swamp hardwoods cover areas aggregating more than 25,000,000 acres. About 71 per cent of the land surface is wooded, and less than half of the wooded area is on farms. The relatively large timbered area, rapid tree growth, level topography, and ease of transportation to inland cities as well as to coastal shipping points are advantages that give the coastal plain great promise for commercial timber growing.

Most of the Station's work has been in the mountains, but within the last three years studies have been started on the coastal plain. Limited funds made it necessary to restrict these studies to problems dealing with the southern pines, and it has not been possible to do any work in the important swamp hardwood forests, nor more than scratch the surface in the studies of the pines. Neither has it been possible to carry on investigations in the farm woodlands of the plateaus. In the mountains the work is being concentrated at branch stations, which will be discussed later. Two branch stations are now being recommended for the coastal plain, as well.

The Station's studies in 1929 fell under the general heads of forest management, protection, and planting (forestation), with a little work on tree studies contributed to projects carried by the Central Forest Experiment Station. The work under these heads is summarized under the topic "Current Investigative Projects." The relative importance placed upon these subjects is indicated by the following statement of expenditures for the fiscal year ending June 30, 1929:

EXPENDITURES FOR INVESTIGATIONS
FISCAL YEAR 1929 1/

		Per cent
Management	$24,583.07	61
Protection	10,284.54	25
Forestation	2,433.52	6
Tree studies	656.07	2
Miscellaneous 2/	2,532.73	6
	$40,489.93	100

ESTIMATES OF EXPENDITURES BY PROJECTS AND LINES OF WORK

CALENDAR YEAR 1930

Allotment (as of F.Y. 1930)		$40,460
Supervision, improvement, supplies, and equipment		12,760
Balance for investigations		27,700
Projects	Estimated expenses	
Management		
Methods of cutting and natural reproduction--hardwoods (Mc-2)	$6,900	
Loblolly pine--reproduction, growth, and management (M-111)	5,500	
Experimental forests (M-1)	1,380	
Natural replacement of chestnut (M-3)	800	
Thinnings: southern pines (Mt-3)	600	
" Biltmore Estate (Mt-1)	480	
" mountain hardwoods (Mt-2)	---	15,660
Protection		
Effect of fire in the mountain region (Pf, A-1)	7,470	
Effect of controlled burning, coastal plain (Pf, C-3)	1,330	8,800
Planting		
Test of species: hardwood types (Fp-4)		
" " " spruce type (Fp-3)	400	400
General study of plantations (Fp-2)		
Mensuration -- Growth sample plots (ME-1)	400	400
Phenology	240	240
Miscellaneous investigations (salary not assigned to projects)		2,200
Total allotted to investigations		$27,700

By regions

Mountains	$18,070
Coastal plain	7,430
Miscellaneous investigations (not distributed)	2,200
	$27,700

1/ Overhead expenses, prorated to investigations in this statement, amounted to $11,821.42, covering such items as rental of quarters, supplies and equipment, routine correspondence, etc.

2/ Items not included as projects in the Station program.

GENERAL STATION ACTIVITIES

Forest Biology

In January, 1930, a representative of the U. S. Biological Survey, Mr. Thomas D. Burleigh, was assigned to the Station for work on problems of game and wild life in relation to forest management and protection. This new activity, which followed strong recommendations from the Appalachian Forest Research Council, is especially welcome for a number of reasons. The maintenance of game in the forest has great promise as an incidental and often a very important reason for the holding and protection of forest lands. It ties in at many angles with the management of forests for timber production and this has direct bearings upon the Station's other investigations. Birds and small animals of various kinds have been found to have a much more important relation to the success and quality of reproduction than had been formerly supposed. There is a balance in animal life which is constantly disturbed by the action of man--through forest fires, hunting, trapping, killing of predatory animals and birds, and through changing the environment as may be done in silvicultural practice. This balance should be thoroughly understood and methods of controlling the proportions of different species should be devised. Thus there is an interrelation of problems within the field of biology and forest management. The biological investigations will undoubtedly contribute in a most important way to most or all the other activities of the Station, while the reverse is also to be expected.

Cooperative Study of Smelter Fume Injury Near Ducktown, Tennessee

At the request of the Ducktown Cooper and Iron Company of Isabella, Tennessee, which supplied funds for the purpose the Station has cooperated with the supervisor of the Cherokee National Forest in making a study of smelter fume injury of the Copper Basin area of Tennessee. The damaged region comprises some fifty thousand acres in which the forest growth was either killed by sulphur fumes or else clear cut for charcoal. The center of the area adjacent to the smelters is at present practically bare of vegetation. Sheet erosion and gullying have proceeded to such an extent that the area is probably the most devastated of its kind in the eastern United States.

The Station prepared for the interested companies a complete report of the studies made and furnished recommendations for the restoration of vegetation.

Because of the unusual soil conditions present, and due to the continued presence of sulphur fumes in the air, the Station does not recommend the region as desirable for the expenditure of public funds for planting or other means of reforestation.

Cooperation with the Forest Products Laboratory

In 1928 the Section of Industrial Investigations, of the Forest Products Laboratory, Madison, Wis., cooperating with the Appalachian Station, made a study of small sawmill utilization in the Southern Appalachian Mountains. The results of the first part of this study for the Pisgah National Forest and adjacent territory in North Carolina, were issued in a 103-page multigraphed report, in December, 1929.

Because of the comprehensive data that were collected and analyzed, relative to the costs and returns of logging different sized trees of different species, this study yielded results that are invaluable for silvicultural work in the mountains. Similar work was started on the coastal plain in October, 1929, in cooperation with the Station's study of selective logging in loblolly pine, reviewed on a later page of this report. The work has so far been done at two localities under different conditions of stand and utilization, and it is planned to continue it in 1930 at a third point. Besides yielding valuable data in themselves, the logging and milling studies will furnish a valuable background of utilization data for the continuing investigations by means of permanent sample plots that were established simultaneously by the Station.

In these studies the Station is also cooperating with the Section of Silvicultural Relations of the Laboratory. Investigations are being made of the properties of wood in trees liberated by logging as compared with trees from closed stands. Samples of loblolly pine trees and of white pines cut in thinning the Biltmore sample plots were sent to the Laboratory for tests.

Under the Station's ordinary sample plot procedure it was often impossible to supply suitable material for laboratory tests without seriously interfering with the purposes for which the plots were established. It is now planned, however, to increase the areas treated so that there will be ample area outside the plots but under similar treatment from which laboratory specimens may be obtained. The new procedure outlined elsewhere for the Bent Creek experimental forest provides for this in the large areas to be treated.

Branch Stations

Concentration of the investigative work at branch stations is particularly important in the territory of the Appalachian Station because of the great variety of forest conditions. The most extreme differences are those between the mountains and the coastal plain and between the farm woodland areas and the larger tracts of timberland; but within each of these groups there are wide variations in climate, soil, and forest type, as well as in economic conditions affecting forest utilization and management. Points selected for branch stations are those at which more important sets of conditions are well represented. All three of the present branch stations are in the mountains, with headquarters at Asheville, N. C., Berea, Ky., and Edinburg, Va. A fourth, to be centered at Elkins, W. Va., is being recommended. On the coastal plain, much of the work during the past two years has centered around Franklin, Va., and Summerville, S.C. These two points have been under consideration for some time as branch station possibilities, and recent developments have opened the way for definite recommendations to this effect.

The work at the branch stations has not only completely justified this plan of procedure but has shown the further necessity of concentrating activities at a single branch until an ample amount of work is under way to ensure substantial results for that locality. Conditions at the several branches are so different that simultaneous studies of any particular subject cannot easily be correlated. When studies are well under way at all the branches such correlations can doubtless be made, and it has therefore been decided to center most of the work for the next few

years at one branch after another. For the year 1930, at least the greater part of the work in the mountains will be done at the Asheville branch, and particularly on the Bent Creek experimental forest.

Experimental Forests

Where suitable areas exist at branch stations, experimental forests are to be developed. Such areas are now available at Bent Creek, on the Pisgah National Forest near Asheville, N. C., and at Berea, Ky. These forests are the means for most effective grouping of experiments, and they will be developed as Station projects according to detailed plans. Their value as demonstrations of experimental methods and comparative results will increase as time goes on. Definite steps toward development of the whole tract as an experimental forest have as yet been taken only in the case of the Bent Creek experimental forest.

Bent Creek experimental forest

Past Work. In 1929 an area of about 68 acres was surveyed and added to round out the experimental forest, by arrangement with Supervisor Mattoon of the Pisgah National Forest. This brings the area of the experimental forest up to about 1,110 acres. The division of the forest into 21 compartments was finished in the same year. Compartment lines were brushed out to a width of 6 or 8 feet, and clearly marked by painting trees on each side of the line. Cement posts were set at all compartment corners and painted angle-irons at bends in the lines. The posts and angle-irons were stencilled with the numbers of the compartments to which they refer.

In 1926, in connection with previous sale arrangements by the Pisgah National Forest, practically all the chestnut on the experimental forest that was of acid wood or pole size was logged. Before cutting, the trees were measured and the stumps were tagged with numbers corresponding to the records, so that the records would contribute to the history of sample plots put in after the chestnut was removed. Three areas of from 5 to 10 acres each were reserved as controls on which no chestnut was cut. In 1927 a 20 per cent cruise of trees 6" d.b.h. and larger, of all species, was made on most of the forest. The forest types on the area were determined and mapped at the same time. The 68-acre addition of 1929 was typed and cruised last year.

Topography, forest types, streams, roads, trails, and compartment lines have been shown on preliminary maps. The data obtained in the 1927 cruise have been allocated approximately to the several compartments. A summary of the types identified in this cruise gives a good indication of the forest composition:

Forest types of the Bent Creek experimental forest

Forest type	Area - acres
Oak - pine	297
Chestnut - chestnut oak	207
Black oak - scarlet oak	143
Old field pine	130
White oak	106
Open	104
Cove hardwoods	62
Oak - hickory	35
Old field hardwoods	26
Total	1,110

The forest is representative of considerable area in and near the Asheville basin, not far from settlements, and between altitudes of 2,000 and 3,000 feet. The stand has been radically modified. Much of it is second-growth on old fields. The remainder has at one time or another been heavily cut over, and the larger trees are principally rejects. Much of the stand was logged to small saw-mills along the creek. There are remains of a number of old farm houses. Grazing is reported to have been heavy on parts of the area at one time. The forest floor over considerable areas is covered with dense undergrowth of laurel and rhododendron. Except for an area probably not exceeding 100 acres that was burned in the spring of 1926, there have been relatively few fires on the forest since the land was first consolidated, about 30 years ago, by Geo. W. Vanderbilt.

Future Work. According to a tentative management plan prepared early in 1930 it is proposed to handle work on the forest so that (1) all experiments will be located in forest types and conditions appropriate to them, (2) adequate space will be provided in advance for each experiment without the possibility of interference between experiments, and (3) the experiments will serve to best advantage gradually to develop the whole forest in such a way that sequences can be followed and related experiments most easily compared. Two general principles will be followed in planning investigative work on the forest: (1) areas will be selected which are best suited for the experiment at hand; (2) the conditions on any specific area will suggest the sort of experiment which may be carried out on it.

Certain general rules will be followed in the development of the forest:

(1) Scattering of experimental work all over the forest is to be avoided: emphasis is to be placed at first on the development of the north end of the tract.

(2) In general, the cruise of any specific unit will not be made until experimental work has been planned for that unit.

(3) Provision will be made for reserving untouched enough areas to serve as checks on work done, and as demonstrations of the natural development of the stands represented.

(4) The project doing experimental work on a treatment unit will, in addition to laying out intensive sample plots within the unit, stand the cost of treating the whole unit by the same methods used on the sample plots.

(5) Records of purposes and results of the treatment, of the condition and volume of the original stand, material removed, and of costs and incomes for the whole treated unit will be kept by M-Station forest. The cost of laying out the intensive sample plots, and keeping data on them will be eliminated from these accounts since they are chargeable to the experiment rather than to the treatment of the area.

Improvement and protection plans are to be drawn up jointly by the Station and the National Forest Supervisor. A plan showing proposed locations of the buildings needed at Bent Creek will be made. A little work remains to be done to complete and bring up to date the maps of the tract.

Berea College forest.

Past Work. A tentative working agreement has been made with President Hutchins relative to experimental work on the forest. The College has been urged to make special efforts to utilize products of the College forest in its wood-working plant. An inspection of the forest and wood-working plant was made in 1928 by R. D. Garver, of the Forest Products Laboratory. His report contains some general and a few specific recommendations, the latter with reference to new manufacturing equipment which could be set up to advantage for working up some products of the College forest for sale.

While the College forest has been utilized by the Station for experimental work dating from 1923, no plan of management has been prepared and there have been no general surveys.

Future Work. In view of the proposal to concentrate most of the studies at Bent Creek this year, nothing is planned for Berea in 1930. A splendid opportunity for telling work exists there, however, contingent largely upon activities by the College aimed to develop the productive capacity of the forest. This should come about through a coordination of utilization - by means of increased variety and volume of output by the College saw-mill and wood-working plant - and forest management according to a detailed plan and survey.

President Hutchins has shown much interest in getting this work organized, especially with regard to utilization. To this end he has requested the help of the Forest Service in obtaining a market study, prior to the enlargement of the wood-working plant which is planned for this year. While the Station cannot undertake the entire work of organizing the forest for continuous supply, its interest in the development of silvicultural and protective experiments makes its active participation very desirable in a number of phases of the work.

Proposed experimental forest.

If the proposed branch stations on the coastal plain and in West Virginia are approved, two or three additional experimental forests are in prospect. Near Summerville, S. C., there are three possibilities, on two of which experiments have already been under way for some time. A similar possibility exists near Franklin, Va. While the plans are less definite for West Virginia, areas on the Monongahela National Forest, the State Forest near Marlinton, and possibly some lands near Webster Springs are available for reservation as experimental forests.

Research reserves.

A memorandum addressed to the men in charge of work in the field during the summer of 1929 contained a suggestion that they be on the lookout for areas within the national forests which might be suitable for research reserves.

An area of about 500 acres in the northern hardwoods type in the Natural Bridge National Forest was visited. It is situated at the head of North Creek in the Glenwood Ranger District and is locally known as Sugarland. The stand is virgin

and is made up of sugar maple, basswood, yellow poplar, red oak, black cherry and considerable blight-killed chestnut. It is 3 miles by trail from the nearest road.

The presence of dead and dying chestnut is typical not only of the forests in the region surrounding Sugarland, but also of a very large part of the Southern Appalachian region. It radically affects the condition of the stand much as a partial cutting of greater or less severity would affect it. Whether or not virgin stands that contain much chestnut should be accepted as research reserves is a question that should be decided. If not, the opportunities for such reserves in the region will be considerably reduced.

Research in cooperation with the National Forests.

The larger part of the Station's work in the mountains has been on the National Forests. While much of it has been on lands that were cut over when the government acquired them, a number of sample plots and investigative areas have been established in connection with Forest Service timber sales, to determine the composition and growth of the reproduction after the cutting. One of the earliest of these studies was made in 1922 on Horse Fork of Curtis Creek, in cooperation with the Pisgah National Forest staff. Tallies were made of stand and reproduction in 1922 and again in 1926. The results of the last examination, published in the Proceedings of the 9th Southern Forestry Congress, give an interesting comparison of the composition found in the original stand and in the reproduction. This comparison, in percentage of species, is shown in the following table:

Composition of original stand and reproduction after cutting, in per cent of number of trees
Horse Fork, Curtis Creek, Pisgah National Forest.

Species	Lower slope		Ridge	
	Timber stand before cutting (7" d.b.h. and larger)	Reproduction (1926) 0-6 in.,d.b.h.	Timber stand before cutting (7 in.d.b.h.and larger)	Reproduction (1926) 0-6 in.,d.b.h.
	per cent	per cent	per cent	per cent
Chestnut	54	15	31	42
Chestnut oak	3	3	39	12
Other oaks and hickory	12	9	9	4
Red maple	6	9	10	13
Yellow poplar	10	24	6	2
Black gum	1	1	4	1
Hemlock	5	3	-	-
Misc. timber species	9	5	1	4
Small tree species	-	31	-	22
Total	100	100	100	100

The "stand before cutting" had been cut-over in the past, leaving an average of 67 trees per acre on the lower slopes, 69 on the ridges. The forest Service timber sale removed an average of 40 and 43 trees per acre on the lower slope and ridge, respectively. The earlier cuttings undoubtedly centered on the better species. In the Forest Service sale, an attempt that was not fully successful was made to have all trees of less valuable species such as red maple and black gum removed, leaving most of the better species, like yellow poplar. The reproduction tally for the lower slope seems to indicate that this procedure worked out fairly well. The proportion of yellow poplar was much increased with little or no increase in the proportion of inferior species. On the ridge the results were not so good. The proportion of chestnut oak in the reproduction is much below the proportion in the stand before cutting, while the quantity of red maple increased. The large amount of chestnut in the reproduction is of little significance, since most of it was already infected with blight in 1926. The next examination, in 1931, should show considerable change in the proportion of species, due to death of chestnut sprouts.

In 1929 a series of three 1-acre and four smaller sample plots were established on a timber sale in the Natural Bridge National Forest, in cooperation with the forest supervisor, to study the results of a supplementary improvement cutting following a timber sale. Data on the cost of girdling and felling undesirable trees were obtained and have been incorporated in the bulletin "Timber Growing and Logging Practice in the Southern Appalachian Region." Results from the girdling, as well as from disengagement cuttings practiced on the smaller plots, will not be available for several years. It can be stated, however, that partial cuttings made previously on the same area by the Forest Service had been extremely beneficial through assisting the establishment of an excellent reproduction of white pine and yellow poplar. This reproduction while further benefitted by the later sale, was jeopardized by the inferior trees left on the ground, which were eliminated by the subsequent improvement cutting.

The extensive study of cut-over areas made by the Station during the last few years was largely on Forest Service timbersale areas, though there was no active cooperation with the National Forest in making the study. Over 300 temporary sample plots, a half-acre in size, were tallied. Preliminary summaries are given in tables in the timber growing and logging practice bulletin. In all except one type - northern hardwoods - the less desirable species outnumbered the more desirable species in the reproduction. This is true of the unshaded as well as of the shaded reproduction. Much of the undesirable reproduction, however, is of chestnut sprouts which will die of the blight. These studies have served to emphase the value of the Station's permanent sample plots on which the progress of reproduction, with and without treatment to encourage the better species, can be observed over a long period of years.

An unsatisfactory condition of stocking was also brought out for the larger tree sizes in the same study. Compared with even-aged second-growth for which data are available, the cut-over areas are as a rule only about half-stocked. Between breast-high diameters of 3 and 9 inches, good trees of desirable species comprise only from 15 to 25 per cent of the under-stocked stands in the different types. The inferior and defective trees are not only of little if any promise in themselves but they are also a means of suppressing the reproduction beneath them. Even sound well-formed trees of good species, if isolated, may develop into limby "wolf-trees" of

little value but of considerable harm to reproduction. A result of the extensive survey was therefore the recommendation that isolated young trees should generally be cut or girdled, so as to leave clear spaces for new reproduction. The best silviculture would of course remove trees of any size that are left on cut-over areas because of defect

A number of other sample plots have been established on the national forest in cooperation with the administrative organization. They include two or three at the Edinburg branch station and one near Deerfield, on the Shenandoah National Forest; two small plots near the Bent Creek Ranger Station, Pisgah National Forest; and two or three other scattered plots on the Pisgah Forest.

The value of research on the part of national forest administrative forces in connection with fire prevention, timber sales, planting, and other technical activities, should be strongly emphasized. The importance of keeping track of reproduction following various methods of cutting in different forest types is self-evident. It affords the only means by which the success of the methods used can be measured, and timber sale records ought to include some periodic statement of the condition of the resulting stand. Although the experiment station is doing intensive work on this subject, the experiments are at relatively few isolated places and cannot be expected to yield results that will be locally applicable to specific sales. The national forests can therefore hardly afford to be without some sort of a systematic record of results, and money devoted to at least a small tally and measurement of the reproduction on representative and distinctive sale areas would be well spent. At the invitation of District 7 the Appalachian Station participated in the preliminaries for a plan of procedure, which was tried out in 1929 and issued as "Instructions for Initial Examination and Report" (S-Sales, D-7, Record of cut-over Areas), April 15, 1930. The chief difficulties in the way of collecting ample records of reproduction are likely to be small funds available for the purpose and the lack of sufficiently trained personnel at all points where the work should be done. For these reasons there is danger that the plans will have to be unduly scaled down both as to the percentage of area to be covered and the volume of data to be collected. It is believed that the importance of this work justifies more funds and if necessary a special personnel.

The records of sales ought also to cover a general idea of the rate of growth and mortality of the larger trees left standing. Perhaps it is unreasonable to expect that very detailed records should be kept for every sale, or even for the more important sales; but a few well located sample plots on each forest will furnish at least a better basis for estimates than now exists. Records so obtained would contribute greatly to a knowledge of the rate of growth on cut-over areas.

The nursery and planting work that is being undertaken by District 7 calls for considerable research, in the more fundamental aspects of which the Station should participate. As brought out in C. F. Korstian's memorandum (RS, Investigative Program) of February 28, the Station and the administrative force could well cooperate in a joint plan for nursery and planting research.

In fire prevention the administrative activities are naturally devoted largely to presuppression, suppression, and construction work, but there is also a field here

for administrative research. Experiments could be carried on to advantage by local forest forces in determining the natural duration of special hazards and the relation of weather conditions to the inflammability of forest fuels. The latter will be of particular importance when fire weather forecasting is established in the Southern Appalachian region.

All of these research activities will tie in with the work of the Station, and it is conceived to be the Station's duty to assist with advice and demonstrations in bringing them about.

CURRENT INVESTIGATIVE PROJECTS

Management

Methods of cutting and natural reproduction in the hardwood types.

Past Work. The studies that fall under this head are the most important of all for the mountain region. Their general purpose is to determine what methods of cutting will give the best results in the quantity and composition of reproduction, its rate of growth, and the growth rate and quality of trees left standing where partial cuttings are practiced. Three lines of procedure have been followed: (1) extensive surveys to determine the conditions actually prevalent on the large areas that have been cut-over in different parts of the region and in different forest types and sites; (2) permanent sample plots on which different methods of cutting are actually tried in comparison with adjacent plots left untreated; and (3) detailed studies of conditions that affect the establishment of seedlings and of other phenomena that have a bearing on the general problem.

In the extensive study of cut-over areas about 300 half-acre sample plots - temporary plots - had been tallied in 13 localities, mostly in North Carolina and Virginia, up to the end of 1928. In 1929 the work was extended to Kentucky and West Virginia, with some additional plots in Virginia. Seven half-acre plots were run on the Robinson Tract of the Kentucky Agricultural Experiment Station near Noble, Ky. On the lands of the Pocahontas Coal Company in Wyoming and McDowell Counties, West Virginia, 10 half-acre plots were run in a variety of different cuttings. In connection with permanent sample plot work on McFalls Creek on the Natural Bridge National Forest, 18 half-acre plots were run in a recently cut-over stand using the regular extensive survey methods. An analysis of the data thus gathered aided in the location of the permanent sample plots later established.

A very general summary of the results obtained up to last year in the extensive survey appears in tables in the manuscript for the bulletin "Timber Growing and Logging Practice in the Southern Appalachian Region." Some of these results were described on a previous page of this report under the heading "Research on the National Forest." The conditions on the cut-over areas are so widely variable, however, that averages do not tell the whole story. Furthermore, the extensive study has served to emphasize the need of more intensive work on the progress of the stand and reproduction from year to year.

Such work is now under way on 25 permanent sample plots. These plots are

scattered at 7 different points in the region. Although all these are at branch stations (except those on the Natural Bridge National Forest, which are along a route between branch stations), the variety of conditions represented is not favorable to an early satisfactory correlation of results. For this reason it is very desirable to concentrate work at different points in succession, until it is clear that studies that will lead to early conclusions for a particular set of conditions are well under way.

The work done at Berea in 1929 consisted only in deferred and badly needed details not connected with measurements of growth and reproduction. It was found that tags had been taken from very many of the trees - almost all the trees on one plot. Their replacement required considerable care and time. To provide against future trouble as well as to get a graphic record of the plots, all trees and stumps on the four plots were mapped. This was done by gridironing the plots with string, and while the string was in place a description of each serially numbered tenth-acre was made, as to character and crown-closure of stand and nature of reproduction. As was done for plot 1 last year, plot 3 (treated) was divided into acre and fraction sections, to accentuate differences in stand and reproduction.

Seven plots were established in 1929 at McFalls Creek on the Natural Bridge National Forest. The plots were put in at the time a "clean-up," or silvicultural improvement of stands following logging was being made by the administrative force of the Natural Bridge National Forest. The stand was chiefly of oaks, chestnut, and white pine, with yellow poplar and hemlock in the coves, and with considerable hickory, black gum, red maple, and other species for which there was no sale value at the time. A heavy reproduction, chiefly of white pine and yellow poplar, had appeared following the opening up of the stand by chestnut pole cuttings, in 1920-21 and 1924-25. In 1928 the saw-timber on this area was selectively logged. No white pine, yellow poplar, white oak, or red oak trees were removed that were less than 16 inches d.b.h. but the other species were marked for cutting to smaller diameters.

An improvement cutting was accordingly made in which the less promising species were felled or girdled. As a rule only the saplings 4 inches and less, d.b.h., were actually cut, all trees larger than this being girdled. The average number per acre of trees cut or girdled was 293, and of these more than 90 per cent were in the 2 to 4 inch class. These small trees were mostly of dogwood, sourwood, and red maple. Of the trees 9 inches and larger that were girdled, most were of red maple, black gum, and hickory, but there were only 10 such trees per average acre.

The expense of the actual felling and girdling was $1.35 per acre, under somewhat higher labor costs than would ordinarily be necessary. Also, because of the unusual reproduction to be released from shade, more work was done than would commonly be required. Ordinarily the better red maples, red gum, and hickories might have been saved to advantage for later demands. If this had been done the cost would probably have been reduced to less than $1.00 an acre.

The condition of the area following the selective logging of 1928 is shown in the following table:

Average number of trees per acre 3 inches d.b.h. and larger

on 18 half-acre plots following logging, McFalls Creek, 1929/1

	Number of trees per acre		
	good form	poor form	Totals
Trees of desirable species /2	33 (33)	21 (14)	54 (47)
Trees of less desirable species /3	34 (40)	117 (151)	151 (191)
	65 (73)	138 (165)	205 (238)

The McFalls Creek plots are in three groups, the largest of which consists of three 1-acre plots. On one of these all trees of less desirable species were removed, on another all trees of poor form, while the third was untreated. As it turned out the two treated plots do not differ greatly since a large proportion of the poorly formed trees were of less desirable species.

A pair of 1/20th-acre plots was laid out in a stand with a rather dense, high undergrowth of laurel (Kalmia latifolia). The overstory, except for a very few promising young trees of good species, was completely removed from both, and the laurel was cut back on one of the pair. A pair of 1/10th-acre plots was established and similarly treated in a stand with a dense undergrowth principally of dogwood, and with an excellent shaded reproduction of white pine and yellow poplar. Labor costs of the cutting were taken in all cases and the resulting behavior of the reproduction will be observed periodically.

Future work. For reasons previously mentioned all work on this project for the ensuing year is to be at the Asheville branch and particularly on the Bent Creek experimental forest. Compartments 1, 2, 3, and possibly 4 in the Bent Creek forest have been selected for the first work under the new management plan. The stands to be treated differ a good deal in composition and condition but all contain many defective and poorly formed trees. Toward the top of the north-facing slope on which the experiments will be made nearly all the trees are very defective. Lower down there are fairly good stands, largely of second-growth with scattered holdovers, mostly defective. Part of the area has a dense undergrowth of laurel, and on another part there is a similar growth of rhododendron. The compartments chosen for this year's work also contain stands of mixed pine and hardwoods.

The purpose of the work in 1930 will be to test methods of converting the existing poor forest - which is typical for large areas in the region - into vigorous stands of desirable species. Clear and partial cuttings will be made over the entire area of a given class of stand except for a portion reserved as a check. Sample plots of an acre or half-acre will be established in each treatment unit for intensive measurement. Methods of eradicating or reducing the competition of laurel and rhododendron will be tried, by cutting back, burning, or poisoning. On some areas the

1/ Bracketed nos. are averages for the permanent sample plots.

2/ Desirable species; white, chestnut, red and black oaks, white pine, yellow poplar, cucumber, hickory, hemlock, black locust, white ash and sycamore.

3/ Less desirable species: black gum, red maple, sourwood, dogwood, chestnut, and scarlet oak.

advance growth will be cut back to determine the efficiency of seedling sprouts. If planting stock is available in the fall or the succeeding spring some planting will be done on portions of the cut-over areas, and it is planned to attempt some direct seeding of oak or other species to reinforce the reproduction where deficient.

Soil improvement is believed to be rather generally important, and soil studies will accordingly be made on the treated and untreated areas. These may extend to attempts to introduce tree species of known value as soil improvers.

In addition to the work on the Bent Creek forest, sample plots on Curtis Creek and elsewhere in the territory of the Asheville branch are to be examined and passed upon with reference to the desirability of continuing them.

Natural replacement of blight-killed chestnut.

Past work. Since chestnut is, or has been, the most abundant timber species in the Southern Appalachian forests, its death from the chestnut blight (Endothia parasitica) is bound to have a radical effect upon the composition of the future forest. Studies were begun in 1924 to determine the nature, extent, and rate of replacement of chestnut by other species and the rate at which the growing stock of the forest will be restored by the replacement species. The first work was a survey of conditions in the oldest infected area in the Northeast, where practically all the chestnut had been dead for a number of years. These studies were conducted in cooperation with the Northeastern Forest Experiment Station and the results have been published. Two 1-acre permanent sample plots were established on the Shenandoah National Forest in 1924. Since then eight 1-acre and two half-acre plots have been established on the Shenandoah and Natural Bridge National Forests and on the Bent Creek experimental forest (Pisgah National Forest), and fifty plots of a square rod each were put in at Bent Creek. On ten of these, yellow poplar seedlings, one year old, were planted to test the desirability of artificially filling in gaps in the stand caused by the death of the chestnut. In 1929 the only work done was the reexamination of interior quadrats in nine plots. It appears from the data that little turn-over in the reproduction occurred during the last year.

Future work. No more sample plots are to be established. The 50 square rod sample plots together with the quadrats in the larger plots at Bent Creek are to be examined in the fall of 1930. In the fall of 1931 the quadrats in all the other large plots should be examined. The remeasurement data are to be compiled as rapidly as opportunities permit, and about 1935 there should be a limited amount of extensive survey work to strengthen the data obtained from the sample plots after the replacement species have become well established. The results of these investigations will be prepared for publication about 1938.

The prevalence of chestnut in the majority of forest types in the mountains, and its death from the blight, will affect the results obtained from many of the sample plots in other projects, so that the special study of chestnut replacement is expected to assist in the interpretation of the findings from other studies. This investigation is very closely related to that of methods of cutting previously described, and a number of the chestnut replacement plots will doubtless be continued as "methods-of-cutting" plots when the replacement study is finished.

Reproduction, growth, and management of loblolly pine.

Past work. This study was begun in 1927 with an extensive survey of reproduction on cut-over and burned loblolly pine lands and a growth study of trees left standing on logged areas. The work was continued in 1929, and a start was made in the preparation of taper alignment charts in the study of increased growth of trees left in logging. Evidences of a change in form of the trees liberated by the cutting are already manifest, although the computations are not yet completed.

In the autumn of 1929 a study of selective logging in loblolly pine stands was begun in cooperation with the Sections of Industrial Investigations and Silvicultural Relations of the Forest Products Laboratory, and with the North Carolina Pine Association. Six contiguous areas of 2.5 acres each were selected on the lands of the Camp Manufacturing Company in Nansemond County, Va.

A one acre sample plot was established in each area and thirty milacre quadrats established in each plot. On the plots all trees over 2.5 in.,d.b.h. were tagged, described in detail, and mapped, and on each quadrat all reproduction up to 2.6 in., d.b.h. was tallied by species and height classes.

The areas were marked for different degrees of cutting and were then cut over. During the logging and milling work detailed time and production records were taken on all felling, bucking, bunching, hauling, loading, and milling operations by the joint party under the direction of the Forest Products Laboratory. Following logging the areas were treated in the following ways: On two of them all hardwoods were cut; on half of the three others all hardwoods under five inches d.b.h. were cut and all hardwoods five inches d.b.h. and over were girdled; on half of each of four areas the slash was lopped and the remaining areas were not touched. Time records were kept for all hardwoods felled and girdled in the treatment. These time studies show that the time necessary for these two operations varied directly with diameter and that girdling required less time than felling.

Four additional sample plots of two acres each were established on the lands of the Foreman Blades Lumber Company in Bertie Co., N. C. These plots were marked selectively for varying degrees of cutting, as follows:

1. A heavy thinning in an overstocked portion of the stand in which the trees are smaller in size and many of them too small for profitable logging and milling.

2. A heavy cut estimated at 12 M. bd. ft. per acre with a residual stand of 2 M. feet reserved as the nucleus for the next cut.

3. A moderately heavy cut of 10 M. bd.ft. per acre and a residual stand of 4 M. bd. ft. retained.

4. A light cut of about 7 M. bd. ft. per acre with a correspondingly large growing stock of 6 M. bd. ft. reserved in the residual stand.

All trees over 2.5 inches d.b.h. on each plot were individually described and their locations mapped. On each plot four 0.01 acre quadrats were established on which all reproduction under 2.6 inches d.b.h. was tallied.

These plots were cut over in January and February, 1930, and detailed logging and milling data were taken by a combined party from the Forest Products Laboratory and the Appalachian Station. After logging the plots were checked over to determine the kind and extent of logging damage, and the quadrats were retallied for the same purpose.

Future work. The quadrats on the selective logging plots in Nansemond County, Va., are to be examined in the spring of 1930, and at that time the effectiveness of poisoning to remove hardwoods from among pine will be tested on some of the plots.

During the summer of 1930 an effort will be made to bring all computing work on the project up to date, and the data obtained in the selective logging study will be compiled for a joint report by the Forest Products Laboratory and the Station. During the year an attempt will be made to find a location for another selective logging study under conditions differing from those previously studied. If possible this additional study will be in South Carolina.

Thinnings.

Past work. The sample plots in the Biltmore Estate plantations were given their third successive thinning in April, 1929. The previous thinnings were in October, 1916 and January, 1923. The experiments are in three types of stands: pure white pine, sugar maple containing some white pine, and a mixed stand of shortleaf, white, and pitch pine. Results up to September, 1928 for the white pine thinnings in the "Old Orchard" and "Apiary" plantations are shown in Table 7 of Dept. of Agr. Miscellaneous Publication 61, "Forest Plantations at Biltmore, N. C." The growth in the unthinned plots maintained for comparison is given in Table 3 of the same publication.

The difference in growth rate between the thinned and control plots in the Old Orchard white pine is very marked. In the thinned plot the annual growth between the first two thinnings was at the rate of 115 cubic feet per acre, while in the six years following the second thinning it amounted to 135 cubic feet. In the two control plots, combined, the annual growth for the corresponding periods was at the rate of only 79 and 27 cubic feet per acre, respectively. In the thinned plot, also, there was removed in the two thinnings a useful volume of wood equivalent to 1,640 cubic feet per acre; in the control plots, of course, there was a total loss of at least some of this wood volume through death and decay. The thinned plot, with 504 trees per acre in 1928, and an increase in total yield of 865 cubic feet per acre, is in a much more efficient condition for growth than the unthinned, overdense control plots with 872 and 1,696 trees per acre, respectively.

In the Apiary white pine, the annual growth rate between the first two thinnings (123 cubic feet per acre), was about double that for the corresponding period in the unthinned plot (63 cubic feet per acre); but for the six years following the second thinning the growth rate of the thinned and unthinned plots was about equal (150 cubic feet per acre per year in round numbers). Evidently the second thinning was considerably too heavy and left the stand too thinly stocked for efficient production. It should be noted, however, that the growth of the unthinned stand was distributed among small trees at the rate of 725 to the acre, while that of the thinned stand was concentrated on carefully selected thrifty trees at the rate of only 336 to the acre.

The mixed pine stand in the Ferry Farm plantation was 17 years old when the thinning experiments were begun. In this stand the shortleaf pine had considerably outgrown most of the white pine without killing it, and one object of the experiment was to attempt to preserve the mixed character of the stand. Of the taller trees in the thinned plot, 95 per cent of the white pines were therefore left standing and only 74 per cent of the shortleaf pines, while of the shorter trees 85 per cent of the white and only 4 per cent of the shortleaf pines were left. As yet the white pines have not made sufficient growth to justify the advantages given them. The procedure has, however, proved fortunate in another way; for when a bark-beetle attack killed several of the shortleaf pines, the smaller white pines were in readiness to fill up the blanks caused by the death of the larger trees. The thinned and control plots have an area of 0.1 acre each.

The plot of mixed pine and maple was put in in one of the 20-year-old Apiary stands, and here the maples were growing so well that it seemed worth while to encourage maple at the expense of all but a very few of the best pines. Most of the pines were, in fact, suffering from the competition of the maples. In 1916, 52 per cent of the living trees were cut; in 1923, 25 per cent.

Wood specimens from 68 of the white pines cut in the 1929 thinning at Biltmore, and from trees in an adjacent, previously unthinned stand, were sent to the Forest Products Laboratory for tests of wood qualities of trees of different crown classes, as affected by thinning. The specimens, which were about 18 inches long, were taken at points in the stem corresponding to heights of 18 inches, 12 feet, and 24 feet, respectively. Results from the tests have not yet been received by the Station.

Another thinning experiment is being conducted in a 40-45-year-old stand of yellow poplar at Cranberry, N. C. The stand is very dense and thrifty, on an excellent site and the growth has been rapid. The dominant trees average between 90 and 100 feet high. Five half-acre plots were established in the fall of 1928. During the winter the preliminary plot tallies were analyzed and a plan for thinning was drawn up. In April, 1929, the plots were marked and thinned.

Three different methods of thinning were used. On one plot a selection thinning removed the largest and best trees in the stand. On another a crown thinning removed the trees which were interfering with the trees chosen as crop trees to be brought through the rotation. On a third plot a low thinning removed the overtopped, intermediate, and some of the codominant trees. Two plots which were left unthinned as checks were marked as though they were to be thinned. A summary of the stands on the plots and of their treatment is given below. (Page 18.)

A thinning study in loblolly and other southern pines was approved last year, but no work was scheduled for it other than the preparation of a working plan, which was completed.

Future work. The Biltmore sample plots are to be thinned for the fourth time in the fall of 1933 or spring of 1934. No definite date is set for additional work at Cranberry; thinnings will be made there when required, and the time of treating the several plots will probably differ on account of the different methods used.

Summary of Cranberry Plots -- Trees 1" d.b.h. and larger

Plot No.	Kind of thinning	Original stand			Trees removed			Remaining stand			Per cent of original stand removed		
		Yellow poplar	Others	Total	Yellow poplar	Others	Total	Yellow poplar	Others	Total	Yellow poplar	Others	Total
		Basal area - square feet per acre											
4	Selection	152.0	51.8	203.8	56.6	26.7	83.3	95.4	25.2	120.1	37	52	41
6	Crown	87.2	62.5	149.7	35.6	30.6	66.2	51.6	31.8	83.4	41	49	44
7	Low	158.0	39.3	197.3	31.5	21.4	52.9	126.6	17.9	144.4	20	55	27
3	Control	143.6	55.8	199.4									
5	Control	122.6	65.8	188.4									
		Number of trees per acre											
4	Selection	258	704	962	66	34	100	192	84	170	26	51	31
6	Crown	172	516	688	88	52	142	672	464	226	5	10	35
7	Low	246	348	594	76	122	198	862	548	396	10	20	33
3	Control	254	462	716									
5	Control	236	680	916									

For the thinnings in the southern pines a supplementary working plan will be prepared to provide for establishment of plots on the lands of the Camp Manufacturing Company in Hertford County, N. C., in cooperation with the Section of Silvicultural Relations of the Forest Products Laboratory. This work will include a combined study of loblolly pine thinning and the effect of density of stocking on properties of the wood. The work outlined in the plan will be carried on during 1930 if time is available.

In addition to the work in Hertford County, N.C., several longleaf pine plots established and thinned by H. H. Tryon on the 10,000 acre demonstration forest of the Southern Railway at Pregnall, S. C., should be examined in 1930. Three sample plots established by District 7 of the Forest Service, on the old Lee National Forest, should be watched and if still intact and undamaged by 1932 they should be remeasured.

Growth studies

Past work. Studies of the growth rate of treated and untreated stands are a part of the methods of cutting and the thinning projects, but a special study has also been started of the growth of juvenile stands. As yet only two series of plots have been established, one on Star Gap Branch of Curtis Creek, Pisgah National Forest, the other at Berea, Ky. Increased growth studies carried on as a part of the loblolly pine management investigations have already been mentioned.

Future work. The plans for the growth sample plot project call for the establishment of a rather large number of permanent sample plots in juvenile stands in which the natural development of stands can be studied from early youth under a wide variety of forest type and site conditions. These plots will be in groups of two or more, as a rule, so that thinning experiments may later be conducted on them. They are expected to yield much valuable information on changes in composition, density of stocking, and the effect of the latter upon the form and growth rate of individual trees, as well as of the stand.

A very important subject is the rate of growth on the partially stocked cut-over areas that comprise so large a part of the Southern Appalachian timberlands. The variability of stocking and site makes it unreasonable to expect that any very accurate general figures can be obtained. It should be possible, however, to work out methods by which the growth on particular cut-over areas can be fairly closely estimated. It is therefore largely a matter of technique. No definite plans have yet been matured for making such a study, but a plan for growth determinations that was prepared1/ in 1920 may contain some suggestions. In the meantime the measurements of reserved trees and reproduction on the various permanent sample plots will provide useful data. It has been planned that full descriptions of crown size and form and of bole condition shall be made on some of the plots, since the changes that take place in trees left more or less isolated are likely to be exceedingly important.

1/ "Growth forecast tables for southern upland hardwoods in the Southern Appalachians," by E. H. Frothingham. Mss. RS, T-1, WO, Dec. 1, 1920.

Protection

Effects of fire in hardwood stands.

Past work. This study was started in 1922 to determine the extent of physical damage to existing stands and reproduction from forest fires. It was conducted by E. F. McCarthy. Areas which had suffered from fire were examined by a strip survey covering about 10 per cent of the area burned. Data were obtained as to the extent of killing, wounding, and recovery of the stands. A total of 311 acres of strip were run, with approximately two square rod sample plots to the acre for the determination of the extent and character of the reproduction. This work was done in nearly all the States in the Station's territory, and a number of extensive and severe burns were examined. The extensive survey was supplemented by the establishment of permanent sample plots to determine the rate and amount of continuing damage after fires.

One outcome of the study of fire damage has been the determination, from the records of a number of fires of different degrees of severity, of the proportionate damage to various sizes of hardwoods. The data when scaled according to per cent of kill for the three-inch diameter class showed a correlation of percentage of kill for the other diameter classes, which suggested that the per cent of kill for a given diameter class could be used as an index to the severity of the fire. The tabulated records for the 311 acres of strip covered in the study (representing over 2,800 acres of burned forest) show that any fire severe enough to kill 50 per cent of the three-inch trees will kill practically all of the one-inch trees, 73 per cent of the two-inch, 34 per cent of the four-inch, 22 per cent of the five-inch, 15 per cent of the six-inch, 11 per cent of the seven-inch, 9 per cent of the eight-inch, and proportionately less of all the larger trees down to about one per cent of the seventeen-inch size class. Some of the larger trees are liable to be killed in any fire through the accidental occurrence of dead wood at their bases. The killing of the trees, however, does not damage the productive value of the forest as severely as the wounding of 30 or 40 per cent of the trees not killed.

Studies of controlled burning in hardwoods were included in the Station's activities for the first time during the past year. These studies were designed to determine the effect of periodic burning upon the mortality and condition of reproduction and timber stand, by species, and upon growth rate.

One two-acre plot was laid out on the Bent Creek Forest in the fall of 1929 and was burned April 10, 1930. Prior to burning trees above 2 inches in diameter were tagged and given individual tree descriptions.

A soil phase was added to the fire damage investigation in 1928. Preliminary studies, the results of which are discussed in earlier reports, brought out the fact that fires exert their chief influence on the mineral soils chiefly through the removal of the litter, rather than through any direct influence upon the mineral soil. During 1929 detailed comparisons were made of litter and soil conditions on similar areas, burned and unburned.

Future work. In the physical damage phase, future studies will include periodic observations of the tagged trees on the controlled burning areas to observe the

kind and amount of damage caused by the fire and the effect of fire upon the growth rate. In addition a detailed study will be made of the influence of fire upon reproduction and seedling establishment.

The studies of fire damage to forest soils will be continued in accordance with the plans for the project, and the controlled burning plot at Bent Creek will be used as a basis for a detailed study of soil changes brought about by periodic burning in the hardwood forest.

The relatively large areas that are burned in spite of the degree of protection that is now available makes the study of fire damage one of the most important on the Station's program. It is realized that for the last three years, following the preparation by E. F. McCarthy of his progress manuscript on fire damage, this study has not received the attention that its importance demands. Much remains to be done on the physical damage phase. For example, the relative resistance to fire of different species and of the same species growing under different conditions has not been worked out experimentally. It is believed that calorimetric studies of bark resistance to heat, together with the reaction of the cambium, will be productive of very interesting results. As affecting the future stands on burned areas the effect of fire on soil fertility and structure needs intensive study in continuance of that already started. One important aspect of this is the rate at which forest soils recover normal productive condition after fires.

Effects of controlled burning in the longleaf pine and loblolly pine types.

Past work. The study of the effect of controlled burning on natural reproduction, growth, and soil conditions in the loblolly pine and longleaf pine types was taken over during 1928 by transfer from the Southern Forest Experiment Station. It was initiated by the Southern Station in 1925, when three contiguous areas, having a variety of species and conditions of stocking, were selected for study. One of these areas, of approximately 18 acres, was designated for annual burning, while the other two, aggregating about six acres, were reserved as checks. Twenty-four 0.05 acre plots were established on the areas. After the measurements were taken on these plots, the 18-acre area was burned over in December, 1924.

During January, 1929, the areas were resurveyed by the Appalachian Station, 12 of the original plots were enlarged, 7 of the original plots were abandoned, 7 additional plots were established, and more detailed data were taken on all of the plots. After the areas had been surrounded by fire lines and the plots examined and put in order the one area was burned over. This fire was quite hot, reaching a temperature of 1500°F., in places. It burned the litter layer from all of the area except in the low-lying spots which were damp or covered with standing water.

A reexamination was made of the milacre quadrats on the burned plots in April, 1929, to determine the mortality caused by the fire. The results of this examination may be summarized as follows:

(1) The average fire killed all loblolly pine reproduction and saplings up to 1" d.b.h. and 12 feet high. In a few cases loblolly pine poles 2" d.b.h. were killed.

(2) About 20 per cent of the longleaf pine seedlings 0.1 feet in height and under were apparently killed by the fire. Most longleaf pine seedlings of this size were entirely defoliated and the terminal buds killed.

(3) All longleaf pine reproduction up to 15 feet in height was practically defoliated by the fire, the needles being burned by the fire or killed by the heat.

The milacre quadrats on all of the plots were reexamined in December by members of the Station staff and P. V. Siggers, Pathologist for the Southern Forest Experiment Station. At that time few accessions were found except where the small hardwoods, which had been killed by the fire, had sprouted prolifically, the sprouts in some cases reaching a height of 5 feet. Following this examination the one area was again burned over by a slow fire which skipped many spots due to dampness and sparseness of the litter. Soil samples were taken on all areas; those on the burned area were taken before and after each fire. These samples were brought to Asheville for studies of physical structure and moisture relationships by C. R. Hursh, Forest Ecologist for the Station.

Future work. The quadrats on the plots which were burned over in December, 1929, will be reexamined in April, 1930. A second examination will be made on all quadrats in December and the one area burned over again if there is sufficient fuel to carry a fire.

Damage from the drought of 1925.

Past work. Two upper slope areas in the Bent Creek forest were placed under observation in September, 1925, following the severe summer drought of that year. A number of trees were tagged and described at the time of the drought and subsequent observations of their vigor were made in 1927 and 1929. Soil conditions were observed at the height of the drought season and comparative observations made the following year. These soil observations indicated that moisture content was reduced during the drought considerably below the minimum for available water in the soil. Final observations on these areas have been made, and the results prepared for publication.

Of the tagged trees within the areas not a single tree that maintained normal foliage during the drought period showed any evidence of injury during the succeeding four years, that could be attributed to the drought. Of the trees showing definite drought injury at the time of tagging (September, 1925) about one-half of the number completely recovered. The remainder sustained injury in the form of dead branches in the crown, or were killed either by the drought or by secondary causes.

There were marked differences in response to drought conditions among the oaks. The leaves of chestnut oak were only moderately or slightly injured during the drought. Trees of this species were quite normal the following spring. No permanent injury could be attributed directly to the drought condition. Black oak showed severe leaf injury during the drought period and all of the trees of this species were dead by 1929. With few exceptions red oak and scarlet oak responded similarly to black oak. The hickory species present--mockernut, pignut, and shagbark--were only slightly injured during the drought period. In most cases recovery among the hickories was complete.

Extensive root excavations were impractical because of rock obstructions, but it seemed likely that root restriction due to rock outcrops or to shallow soil in rock pockets was the significant factor responsible for the drought injury. The soil throughout the areas under observation was shallow, frequently being less than 18 inches in depth. During normal seasons such soils support a heavy vegetation due to the ground water moving from above. In periods of drought, however, there is no movement of ground water and these thin soils dry out rapidly and injury to the vegetation is a natural result.

Meterological studies have established the fact that fluctuations from the normal have frequently occurred in the Southern Appalachians and indicate that drought periods are to be expected in the future.

Future work. The publication of the results referred to above will constitute the completion of the project and it will be discontinued.

Planting

Tests of Species in Plantations.

Past work. The first plantings designed to test the suitability of species to conditions in the region were made in 1923 in the spruce type near Mt. Mitchell, N. C. The size of the plots has been standardized at 0.1 acre containing 100 trees. Subsequent additional plots have brought the total to 80 in this type. Only seventeen species, all conifers, have been planted. The large number of plots has been necessary because of permutations of species, age and class of stock, and conditions on the ground. Variations in methods of planting and density of stocking have been avoided.

In the hardwood and pine types at lower altitudes conifers and hardwoods have been tested. About 50 species have been planted, chiefly in small, arboretum tests. These have been confined to the Bent Creek experimental forest and the immediate vicinity. Spring planting during April, 1930, included 12 species in the arboretum and small field plantings of 3 species.

Future work. While the importance of planting studies has been urged in the past by the Station, the need for concentrating on other subjects has prevented the Station from doing as much in this direction as it would have liked. In the aggregate there is a large area in the region - abandoned fields, heavily burned areas, and lands otherwise denuded of forest growth - on which forest planting would be very desirable. The forest nurseries maintained by the State foresters under the Clarke-McNary Act, at which planting stock can be obtained at cost by State residents, are stimulating planting. Before planting can be widely and successfully practiced, however, a great deal more must be known about the adaptability of species to sites, the methods to be used in planting, the kind of stock most practicable for use, the best seasons for planting, the spacing of the seedlings, the combinations of species that go well together in mixed plantations, and many similar subjects. There is a wide field for experiment in the subject of under-planting in natural stands that are too thin or in which the introduction of new species is desirable. Recently the question of planting certain species to improve soil conditions has come up, and this appears to have great possibilities in restoring the fertility of soils that are poor because of past fires or of exposure.

As yet the funds available for this purpose are totally insufficient in view of the heavy demands that are being made by other lines of investigation. It is believed essential that funds should be specially provided for planting investigations at the earliest possible date, and this is strongly recommended.

In the meantime the work for 1930 is being planned on the same small basis as heretofore. A little planting stock raised in the Station's experimental beds in the Champion Fibre Company's nursery at Canton, N. C., remains to be planted, and this will be used next spring at Bent Creek and Mt. Mitchell. Some underplanting will probably be done in connection with the methods of cutting study at Bent Creek. There will be closer association with the studies of the relation of fires to soil, through under - and interplanting of stands on depleted soils. A few small experiments are planned to study the possibility of extending the occurrence of species up slopes from coves, etc. It is also planned to start, on a small scale, a study of water requirements of two or three of the more important species.

Studies of plantations.

Past work. This has been a rather desultory project, carried by the Station in order to assemble data on the results obtained in past planting in the Appalachian region. Work has been done as opportunities were found for it, and a number of plantations have been examined in addition to the Biltmore plantations which were reported in Department of Agriculture Miscellaneous Publication 61.

Future work. It is planned to continue this project as opportunities arise to examine past plantings in the region.

Forest Insect Investigations

Work in 1929

Because of J. A. Beal's transfer to the station recently established at Portland, Oregon, R. A. St. George was temporarily assigned to this Station to conduct the forest insect investigations in 1929. Mr. St. George was assisted by field assistants H. K. Rippey and R. W. Caird. Mr. Caird was assigned to the study of physiological problems connected with trees attacked by the southern pine beetle.

The southern pine beetle.

This year, as previously, the forest insect work was centered around the study of the southern pine beetle, particularly with regard to the importance of environmental factors in relation to outbreaks of this beetle. Additional data were secured, emphasizing the close correlation which exists between climatic conditions and beetle abundance. Excess and deficiencies of rainfall, extreme high or low temperatures were found to have a direct effect upon the prevalence and development of broods of this beetle. Additional evidence was also secured indicating the attraction of the beetle, when present in small numbers, to injured trees.

Following a mild winter the beetles were abundant during the early spring of 1929 and a rather heavy emergence was anticipated. An unexpected excess in precipi-

tation during April and May, amounting to 5.4 inches in some localities, and coming just as the beetles were emerging, resulted in their sudden disappearance so that by June 15 hardly a beetle could be found. The excess of rainfall disappeared by early June and during July a deficiency existed which had increased by August to 3.34 inches around Asheville. Simultaneously reports of outbreaks began to come in, others were found in the surrounding forest. Many weakened, lightning-struck or windthrown trees were found infested and, as a result, beetles were attracted to surrounding trees and infestations were built up. These infestations were located in the Pisgah and Unaka National Forests and on private land.

The largest outbreak occurred at Hot Springs, N. C., in the French Broad division of the Pisgah Forest. Here some 2,716 old field pines were found attacked on an area of about 30 acres. Another slightly smaller one was found at Cherokee, N. C., on the reservation; other spot outbreaks were located in this vicinity. Several more small attacks were found in the Bent Creek and Billy Moore Creek sections of the forest.

It is quite significant that the rather general low temperatures (near zero) of November 30 resulted in killing a rather high percentage of the broods of the beetle that were overwintering between the bark and the wood. However, the more mature specimens in the outer bark were unaffected and unless an excess of rainfall occurs again during April and May there should be quite a heavy emergence. This information was obtained from an examination of samples of infested bark from the affected areas.

Quite a large number of beetle-infested trees were injected again this year with poisonous solutions to note possibilities of this method in controlling bark-beetles. Through improvements in technic, considerable advance was made.

The seasonal cutting experiments, in which pine trees were girdled in various ways during every month of the year to note their attractiveness to barkbeetles, was completed and the data are being analyzed and results prepared for publication. It was determined that during endemic periods the southern pine beetle was definitely attracted by certain weakened, girdled trees. Other interesting results were obtained relative to the effect of girdling upon ring growth and the length of life of trees following various methods of ringing.

An examination of trees on areas burned during the previous year or two, which had attracted the southern pine beetle immediately following the fire, revealed no further activity during 1929.

The locust borer.

Studies relating to the control of the locust borer (Cyllene robiniae) by spraying were continued. Diluted solutions found effective the previous year were tried with highly successful results which lowered the cost of application. Arsenical sprays, orthodichlorobenzene emulsion, ortho and kerosene, and a paradichlorobenzene-pine tar emulsion were used.

Crude product experiment.

Additional wood creosote mixtures were applied to green oak and pine logs to note their effectiveness in protecting the wood from attack by barkbeetles and wood-boring insects. Some of these were found effective against barkbeetles and certain types of woodborers, but not very effective against pinhole borers (ambrosia beetles).

Placing brush over piles of green pine logs, located both in the sun and shade, proved inaffective against most barkbeetle and woodborer attack. The logs on the ground under the piles remained green and very moist, and were the only ones not injured.

Appalachian logging and milling study

An entomological report covering insect losses to green hardwood logs and lumber, cut at small mills in sections of the Pisgah and Shenandoah National Forests during 1928, was prepared during the year. This was a study conducted by the Forest Products Laboratory in cooperation with the district office and the Appalachian Forest Experiment Station of the Forest Service and the Office of Forest Pathology.

Most of the insect injury was confined to chestnut, oak and locust logs. Poplar logs were relatively free from such injury. Two types of pinhole borers were mostly responsible; one, an ambrosia beetle, Corthylus columbianus Hopk., which made defects (pinhole or "spot") in white oak, and the other a timberworm, Melittomma sericeum Harris, which made defects ("shot") in chestnut.

Information was obtained relative to the following insect injury in chestnut and chestnut oak trees: percentage of injury in log run lumber, in various grades of lumber; percentage of area affected; percentage of loss due to degrade according to grade; rate of loss per thousand board feet; and percentage of loss according to the species of wood.

Plans for 1930

Southern pine beetle

Studies initiated in previous years will be continued.

Tree injection

Previous work on injecting poisonous solutions in attacked trees will be continued with the hope of obtaining a method suitable for practical application in the control of barkbeetles.

Insects in relation to fire

A study of this problem will also be continued as opportunities permit. The southern pine beetle, turpentine beetles, Ips barkbeetles, various woodborers and ambrosia beetles are attracted to trees on burned areas and serve as an indicator of the severity of fire injury.

Insects in relation to decay of slash

As much time as possible will be devoted to the study of the importance of insects as a factor in the rate of decay of slash when the latter is handled in various ways.

Locust borer

This problem will be continued, especially observation of permanent sample plots where thinnings have been made. Further experimental spraying and injection work will be done as time permits.

Crude products study

A number of standing trees will be injected with poisons to determine the possibilities of obtaining a thorough distribution of the material before the death of the tree. The sections will then be tested under varying conditions to note resistance to insect attack and rate of decay.

Some additional spraying and dusting work is contemplated to protect green logs from insect injury.

FOREST PATHOLOGICAL INVESTIGATIONS

Work done in 1929

The study of the influence of bluestain fungi in the death of southern pines attacked by the southern pine beetle was continued during the past year. Additional inoculation experiments, and experiments on the ascent of dye in stained and unstained saplings, indicate that the upward flow of liquids in stained areas is checked. Moisture determinations made on discs taken at 2-foot intervals from attacked trees show that the water content decreases from the base to the top. In normal trees the reverse is found; water increases from the base to the top. Data collected during the past year confirm the ideas previously suggested, that the girdling effect of tunnels made by the southern pine beetle are sufficient eventually to kill infested trees but that bluestain fungi are the immediate cause of the death of attacked trees.

Data on heart rots of hardwoods were augmented by the collection of a considerable number of sporophores and rot specimens and by participation in selective logging studies in the coastal plain. Detailed cultural studies of heart-rotting fungi were temporarily discontinued. The pathological aspects of several burned areas in mountain hardwood forests were, however, extensively studied.

Plans for 1930

The necessity for further information on the pathology of mountain hardwoods as a help towards the solution of silvicultural problems is becoming increasingly apparent. Studies of the effect of single and multiple burns on severity of scarring and the subsequent entry of decay-producing fungi, the relative resistance of different species to scarring and decay, and the many factors affecting the entrance of

fungi through fire scars, are considered particularly desirable. During the coming year such investigations will be emphasized. Work on the bluestain problem and cultural studies of heart-rotting fungi will also be continued.

Biological Studies

As a Biologist has been assigned to this Station only since the first of the year, little information of practical value to the successful practice of silviculture in the Southern Appalachians has been obtained up to this time. The basis for all biological work being a thorough knowledge of the wild life now existing on these mountainsides, the preliminary work has involved detailed observations on the distribution and abundance of the birds and mammals indigenous to this region. Both for the purpose of identification and for the analysis of stomach contents, specimens of all birds and mammals that could be secured have been collected and represent fairly well species occurring here during the winter months.

Intensive trapping of the smaller mammals on certain areas has been started to determine their abundance and their influence on the reproduction of such species as the oaks and yellow poplar. There is apparently a serious lack of reproduction on the mountain slopes here and the agencies responsible for the destruction of the seed can only be guessed at at the present time. It is highly important that the guilt be fixed beyond question that suitable methods of control can be recommended and better stands of the more desirable species be secured in the future. Present indications are that rodents are unexpectedly scarce on these mountainsides, and the larger predators, such as foxes and skunks, unusually plentiful, but the data available are still too meager to warrant any definite statements. Deer unquestionably destroy a large proportion of the acorn crop each fall, but how serious their depredations are can only be surmised at this time.

Game management should play an important part in forestry practice, and the relationship of the larger mammals to timber production will be an important phase of future work. This will invoke a detailed study of food habits, maximum population on a given area, enemies, and control measures in case of serious injury to present stands of timber.

Plans for the future

No definite projects are being outlined at this time until a more thorough knowledge has been acquired of conditions throughout this region, and of the individual problems that should receive the most consideration. Proper orientation in a new region is quite desirable and a working knowledge of existing wild life rather essential before definite recommendations are made as to problems to be attached and methods to be employed.

Botanical Studies

The only botanical investigation that has been carried by the Station as a project is a study of phenology, or the periods of different vegetative activity of tree species. To be fully productive the observations of budding, leafing, fruiting, etc., must be paralleled by climatic records. The project was first undertaken last

year, and because of the pressure of other work, the failure to find competent observers permanently located at suitable points, and the difficulty of getting simultaneous records of climatic factors, very little has been done on it. Some observations were made in the spring of 1930, however, and it is planned to take steps during the year toward organizing the work on a systematic basis.

INVESTIGATIVE NEEDS

In 1929, 61 per cent of the Station's allotment was spent on management studies, 25 per cent on protection, and only 6 per cent on forestation. The importance of forest management and protection does not permit of any curtailment of investigative funds such as would be required if other new activities were to be started without additional funds for the purpose. But there are several important lines of work on which the Station has not been able to do anything and which ought to be started without further delay. Among these are studies of the relation of watershed forests to the run-off of streams; the means for preventing or reducing erosion; and the growth and management of swamp hardwood forests on the coastal plain. Of the studies already on the Station's program, it is believed that those of forest planting and of forest fire damage and protection should be materially strengthened.

Forests and Stream Flow

Mountain freshets cause great damage in themselves, and the rapid collection of the tributary freshets results in severe flood conditions in the main streams all the way to their mouths. Superficial evidence, partially reviewed in last year's report, points to the forest cover as an influence in modifying the rate of run-off from tributaries and the amount of sediment carried. The importance of controlling flood waters and of retarding the rate of sedimentation in collecting basins and storage reservoirs appears to justify beyond question the allotment of enough funds to establish the effects of different kinds and conditions of watershed cover in restraining run-off and sedimentation. A preliminary working plan for such an investigation has already been prepared. A study of this character will require the active cooperation of other agencies with the experiment station, and detailed preparations must be worked out well in advance. We believe that this investigation should be no longer delayed and recommend that the necessary steps be taken to begin work on it next year.

Soil Erosion

Erosion of cleared and cultivated lands is extremely serious on the rolling plateaus as well as on the smaller areas that are or have been farmed in the mountains. In "Soil Erosion a National Menace" (Dept. of Agr. Circular 33. 1928.), H. H. Bennett describes the heavy erosion that is taking place in the great Appalachian Valley, the smoother uplands of Kentucky, and much of the piedmont and Appalachian plateaus, and cites an example in the piedmont region of North Carolina in which an annual loss of 24.9 tons of solid matter per acre occurred on an uncultivated plot under less than normal rainfall. Certain piedmont areas whose records are known have, within a period of 30 years, lost their top soil entirely, 10 inches or more of loam and clay loam having been washed off down to the clay subsoil. The loss for the entire Appalachian region obviously must have a very important bearing on the

prosperity of the region. Little or nothing is being done to stop the wastage of the topsoil with its plant food, and in fact very few suggestions have been made for controlling erosion. The loss is so large and constant that a comprehensive study leading to means for preventing or mitigating erosion are warranted. Such studies, by the Appalachian Station, in cooperation with other appropriate agencies, are strongly recommended for the near future.

Coastal Plain Studies

The large coastal areas of swamp and bottomland contain valuable forests that are being cut over for lumber and pulpwood without regard to their future continuance. There is no information available as to proper methods of treatment for continuous timber production and the cost of such treatment. For the coastal plain in general, with its possibilities for the rapid and economical timber production, investigations of growth-rate, reproduction, and other fundamentals of forest management should be carried on much more completely than is now possible. As a means for conducting such studies to best advantage one or two areas of from 2,000 to 5,000 acres should be provided entirely for experimental and demonstration purposes. It is hoped that funds can soon be made available for the purchase of such tracts, which should be so located as to be representative of a variety of important forest conditions and at the same time be reasonably accessible as demonstration areas. Funds should also be provided for carrying on the experimental work on these areas and for their protection.

Planting

The amount of forest planting on abandoned fields and lands otherwise without forest is increasing in the region and is being stimulated by the State forest nurseries which supply planting stock at cost. To avoid the mistakes that have led to failure of plantations in this and other regions in the past, a great deal must be learned about adaptability of species, planting methods, seasons for planting, soil conditions, spacing, and other matters. Forestation studies by the Station have hitherto been limited to the mountains and have had to give place to other studies under way. Very little work could be done. There is a growing need for planting studies throughout the entire territory covered by the work of the Station, and this should be provided for by special funds. Such an increase in the Station's allotment is recommended.

Fire Damage Studies

It is proposed to extend the studies related to forest fire as soon as an additional man can be added to the staff for this purpose. Fire studies have received about a quarter of the Station's allotment. It is believed that the importance of the subject justifies either an addition to the Station's funds or a proportionate increase to about 30 per cent of the allotment.

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